

USAF APPROVED HEARING PROTECTION DEVICES
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Air Force Research Laboratory
Human Effectiveness Directorate
Crew System Interface Division



HPD evaluation provided by:
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Contents:

- I. Attenuation of HPDs & Headsets
- II. Explanation of NRR
- III. Explanation of Method A vs. Method B
- IV. Explanation of C-A
- V. Order of Preference for calculating HPD noise attenuation.
- VI. POCs

I. Attenuation

(All testing accomplished using American National Standards Institute (ANSI) S12.6-1984 for devices tested using method A, ANSI S12.6-1997 for devices tested using method B.)

(Active Noise Reduction (ANR) Headsets, also known as Electronic Noise Canceling Headsets and Muffs, will be covered in a separate listing since unique tests are required for ANR products.)

ANSI Test Method A: Evaluation of HPDs with trained and experienced test subjects. Fitting the HPD is assisted/facilitated by the experimenter. This is considered best-case data.

ANSI Test Method B: Evaluation of HPDs with naïve test subjects; must obtain their instructions for fitting and use solely from the manufacturer's written instructions accompanying the packaging. No instruction from the experimenter is allowed. This method is proposed to estimate field performance in commercial industry. However, there is debate about how well it suits DoD since service members in a hearing conservation program receive annual training. Devices tested using method B are highlighted and italicized.

C-A Values: Evaluation technique devised by AFRL. See page 7 for values. At this time, current C-A data are still not available for all listed HPDs – updates to come from AFRL/HECB, Wright-Patterson AFB as more testing is accomplished.

Insert Devices	Octave Band Attenuation									NRR
	<u>125</u>	<u>250</u>	<u>500</u>	<u>1K</u>	<u>2K</u>	<u>3.1K</u>	<u>4K</u>	<u>6.3K</u>	<u>8K</u>	
V-51R										
Mean Attenuation	24	24	26	33	38	38	33	36	38	21
Standard Deviation	4.1	4.3	3.6	5.2	6.0	4.9	4.2	6.5	6.2	
XSM NSN 6515-00-442-4765										
SM NSN 6515-00-467-0085										
MD NSN 6515-00-467-0089										
LG NSN 6515-00-442-4807										
XLG NSN 6515-00-442-4813										
Comfit-Triple Flange										
Mean Attenuation	28	28	30	32	43	45	43	43	45	20
Standard Deviation	5.1	5.5	6.3	6.1	7.5	7.8	7.6	5.4	4.9	
SM NSN 6515-00-442-4821										
MD NSN 6515-00-442-4818										
LG NSN 6515-00-467-0092										
3M 1110										
Mean Attenuation	22	25	28	29	34	41	40	40	42	19
Standard Deviation	5.1	5.4	5.6	6.1	5.4	4.5	4.2	5.1	4.5	
E-A-R Classic (Foam Disp.)										
Mean Attenuation	32	35	36	40	43	47	45	45	45	27
Standard Deviation	4.8	6.1	6.2	6.1	5.4	5.1	2.8	4.2	4.6	
NSN 6515-00-137-6345										
Flents Quiet! Please										
Mean Attenuation	19	21	23	25	30	37	38	39	40	11
Standard Deviation	7.0	8.0	8.0	7.0	4.0	6.0	5.0	6.0	5.0	
Flents Silaflex (silicone)										
Mean Attenuation	21	21	19	28	42	44	41	40	37	16
Standard Deviation	4.5	4.1	5.0	5.4	3.3	4.7	4.9	3.1	6.4	
NSN 6515-00-135-2612 24 pairs										
NSN 6515-00-133-5416 100 pairs										
Howard Leight Max 1										
Mean Attenuation	29	30	32	30	36	43	46	47	47	18
Standard Deviation	8.0	8.1	7.6	7.2	4.0	4.5	4.9	3.3	3.8	
NSN 6515-01-329-4700										
Moldex Purafit 6800										
Mean Attenuation	24	22	23	25	30	38	38	39	40	8
Standard Deviation	8	10	10	9	5	7	7	8	7	

Circumaural Muffs	Octave Band Attenuation									NRR
	<u>125</u>	<u>250</u>	<u>500</u>	<u>1K</u>	<u>2K</u>	<u>3.1K</u>	<u>4K</u>	<u>6.3K</u>	<u>8K</u>	
3M 1435										
Mean Attenuation	10	14	21	28	30	33	35	34	32	16
Standard Deviation	3.6	2.5	4.7	4.1	4.1	4.5	3.4	3.5	6.2	
3M 1440										
Mean Attenuation	12	18	25	30	31	34	37	38	37	18
Standard Deviation	3.6	3.8	3.6	4.8	3.0	3.6	3.5	2.9	5.1	
Aero Earmuff 1000										
Mean Attenuation	10	13	22	31	29	35	34	35	37	13
Standard Deviation	3.6	5.8	3.4	6.0	3.8	3.4	5.5	5.4	5.6	
Bilsom 707 Impact										
Mean Attenuation	11	12	21	25	22	27	31	35	36	10
Standard Deviation	4.9	3.9	5.8	5.2	5.2	6.3	5.8	4.7	4.0	
Bilsom 727										
Mean Attenuation	10	18	27	30	33	38	33	33	32	18
Standard Deviation	3.0	2.5	2.3	2.5	7.2	3.3	3.0	3.5	4.7	
Bilsom Blue 2308										
Mean Attenuation	7	10	17	28	30	35	36	36	34	13
Standard Deviation	3.8	3.5	2.7	3.4	3.1	3.9	4.2	4.9	6.9	
Bilsom Viking 29										
Mean Attenuation	15	21	30	34	32	36	41	41	40	22
Standard Deviation	3.1	4.2	3.4	3.7	3.5	2.9	3.5	4.7	5.7	
Blue Point GA 3000										
Mean Attenuation	16	18	28	39	34	33	33	34	32	19
Standard Deviation	4.4	4.4	4.1	4.4	3.1	2.5	3.2	4.1	6.2	
Cabot 1720										
Mean Attenuation	7	14	21	30	31	32	34	35	34	13
Standard Deviation	5.4	4.5	5.0	5.0	3.5	3.9	3.6	3.7	5.0	
David-Clark 310										
Mean Attenuation	12	18	27	34	30	39	37	37	36	17
Standard Deviation	3.9	3.6	5.3	5.9	5.3	4.1	4.1	3.6	3.2	
E-A-R 1000										
Mean Attenuation	8	14	24	28	24	28	26	25	27	14
Standard Deviation	3.3	2.9	3.6	4.5	2.5	2.9	4.6	5.3	5.0	
E-A-R 820										
Mean Attenuation	7	9	18	27	27	32	32	32	30	10
Standard Deviation	3.9	4.3	4.9	4.4	4.4	3.9	4.5	6.3	7.5	
E-A-R 9000										
Mean Attenuation	9	15	25	25	23	26	25	23	25	14
Standard Deviation	3.5	2.5	2.5	5.9	2.9	2.4	2.0	3.1	3.1	
Gentex Wolf Ear	<u>125</u>	<u>250</u>	<u>500</u>	<u>1K</u>	<u>2K</u>	<u>3.1K</u>	<u>4K</u>	<u>6.3K</u>	<u>8K</u>	<u>NRR</u>
Mean Attenuation	8	14	21	22	20	30	35	35	36	10

<i>Standard Deviation</i>	3.4	3.7	5.1	4.0	5.0	6.4	6.7	5.4	5.8	
Howard Leight QM 24										
<i>Mean Attenuation</i>	10	13	18	28	27	29	29	32	33	10
<i>Standard Deviation</i>	5.7	6.1	5.0	4.7	3.9	4.2	3.0	5.8	5.9	
Howard Leight Thunder 29										
<i>Mean Attenuation</i>	11	14	19	32	34	38	33	34	32	13
<i>Standard Deviation</i>	3.5	3.7	5.4	6.0	6.5	4.7	4.8	4.4	4.4	
NSN 4240-01-357-3998										
MSA Economuff										
<i>Mean Attenuation</i>	9	13	18	24	31	32	32	33	31	7
<i>Standard Deviation</i>	7	4	2	10	5	4	3	5	5	
MSA Mark IV										
<i>Mean Attenuation</i>	14	16	22	32	30	40	37	35	34	15
<i>Standard Deviation</i>	4.0	5.0	5.6	5.5	4.6	6.2	5.5	5.3	6.7	
MSA SlimPro Plus										
<i>Mean Attenuation</i>	14	17	24	33	32	34	33	32	31	18
<i>Standard Deviation</i>	5	4	4	5	3	4	3	5	5	
North 28-45-00										
<i>Mean Attenuation</i>	4	9	17	25	29	30	22	25	24	9
<i>Standard Deviation</i>	3.5	4.3	5.6	3.6	4.8	5.1	3.0	4.6	6.9	
Peltor H10A										
<i>Mean Attenuation</i>	12	18	27	34	35	36	40	37	35	17
<i>Standard Deviation</i>	4.9	2.9	5.8	6.7	5.2	5.1	5.4	4.3	8.8	
Peltor H7A										
<i>Mean Attenuation</i>	10	19	27	33	33	34	34	30	33	19
<i>Standard Deviation</i>	4.5	3.1	2.9	4.2	3.5	3.0	2.2	2.8	2.8	
Safety Direct RBW-71										
<i>Mean Attenuation</i>	7	11	18	33	34	43	30	30	29	9
<i>Standard Deviation</i>	4.1	5.5	7.2	6.6	5.5	7.6	7.9	4.1	5.0	
Safety Direct USN-86 "Flight Deck"										
<i>Mean Attenuation</i>	17	24	30	39	32	32	32	31	32	21
<i>Standard Deviation</i>	4.4	3.5	5.7	4.1	3.5	4.0	4.7	3.6	4.4	
NSN 4240-00-759-3290										
Tasco Golden Eagle 2950										
<i>Mean Attenuation</i>	16	21	31	41	37	38	37	34	34	23
<i>Standard Deviation</i>	2.9	2.8	3.9	4.8	5.4	6.1	3.7	2.8	5.0	
Tasco Sound Shield 2900	125	250	500	1K	2K	3.1K	4K	6.3K	8K	NRR
<i>Mean Attenuation</i>	14	20	28	38	35	39	38	36	35	19
<i>Standard Deviation</i>	3.0	3.6	6.7	3.9	5.5	5.2	6.1	4.0	3.4	

Vallen Pro-Max 1										
Mean Attenuation	15	21	30	35	33	34	35	36	33	21
Standard Deviation	3.9	4.4	4.3	3.8	4.0	3.3	2.4	3.9	6.3	
Willson 365-Sound Barrier										
Mean Attenuation	13	19	24	38	32	34	36	37	36	17
Standard Deviation	3.8	5.3	5.3	6.5	4.6	4.6	6.3	3.5	4.7	
NSN 4240-01-256-3350										
Willson 365A										
Mean Attenuation	15	18	23	33	31	28	34	37	37	16
Standard Deviation	5.5	5.9	5.2	4.6	4.1	3.0	3.4	3.4	2.9	
Willson 365GS										
Mean Attenuation	13	19	24	38	32	34	36	37	36	17
Standard Deviation	3.8	5.3	5.3	6.5	4.6	4.6	6.3	3.5	4.7	

Communication Headsets	Octave Band Attenuation									NRR
	125	250	500	1K	2K	3.1K	4K	6.3K	8K	
Astrocom 81349-MIL-H-87819										
Mean Attenuation	16	20	26	41	42	36	33	32	32	19
Standard Deviation	4.5	3.7	5.3	7.0	4.8	4.1	5.6	4.2	5.5	
NSN 5965-01-204-8505										
Astrocom H157A										
Mean Attenuation	10	12	16	22	27	35	38	38	38	11
Standard Deviation	5.1	2.8	4.6	4.3	4.5	5.2	4.5	5.7	8.5	
NSN 5965-01-128-1410										
David Clark H10-76										
Mean Attenuation	14	20	20	21	33	37	38	34	31	14
Standard Deviation	4.0	3.7	3.1	4.9	3.4	4.3	4.6	7.3	7.4	
NSN 5965-01-390-9240										
David Clark H133C										
Mean Attenuation	22	24	31	26	27	29	37	34	34	17
Standard Deviation	5.5	5.6	5.3	3.2	5.4	3.9	4.9	2	3.9	
Peltor Lite-Com										
Mean Attenuation	12	19	24	34	30	33	36	35	35	20
Standard Deviation	3.1	2.7	2.4	3.4	3.8	2.8	2.7	3.9	3.2	
Roanwell 81349-MIL-H-87819										
Mean Attenuation	18	18	26	35	31	34	35	35	34	14
Standard Deviation	5.3	6.7	5.2	8.7	6.4	8.2	7.4	7.2	6.5	
NSN 5965-01-204-8505										
Roanwell 495-622-001-604	125	250	500	1K	2K	3.1K	4K	6.3K	8K	NRR

Mean Attenuation	12	18	23	22	23	29	31	32	32	13
Standard Deviation	6.9	5.2	5.2	3.4	3.2	3.3	3.9	5.9	5.8	
Wire-Com De-Icing										
Mean Attenuation	13	15	26	32	30	34	38	40	38	20
Standard Deviation	3.8	1.7	3.5	3.6	3.6	2.5	2.8	4.0	4.0	

Helmet	Octave Band Attenuation									NRR
	<u>125</u>	<u>250</u>	<u>500</u>	<u>1K</u>	<u>2K</u>	<u>3.1K</u>	<u>4K</u>	<u>6.3K</u>	<u>8K</u>	
HGU-26/P With MX 8376/AR ear cups										
Mean Attenuation	7	6	14	22	33	43	44	40	37	6
Standard Deviation	5.1	5.6	5.0	4.4	6.5	5.7	5.7	11.0	10.7	
HGU-26/P With Pillow Block Ear pad										
Mean Attenuation	2	6	10	13	20	28	30	37	35	2
Standard Deviation	5.8	5.4	5.2	5.1	7.2	7.8	9.5	7.4	5.5	
HGU-53/P, Gentex										
Mean Attenuation	15	8	19	26	39	46	50	54	53	10
Standard Deviation	4.4	2.4	6.9	7.8	5.7	4.9	4.2	5.3	6.3	
HGU-55/P, Gentex										
Mean Attenuation	10	5	19	31	44	46	49	50	50	12
Standard Deviation	4.1	2.8	3.1	5.1	3.4	5.0	7.3	6.4	6.8	
SPH-4B, Gentex										
Mean Attenuation	14	13	24	37	38	40	40	45	43	20
Standard Deviation	2.8	2.2	2.2	5.4	2.6	4.0	4.3	5.0	4.8	

Plug and Muff	Octave Band Attenuation									NRR
	<u>125</u>	<u>250</u>	<u>500</u>	<u>1K</u>	<u>2K</u>	<u>3.1K</u>	<u>4K</u>	<u>6.3K</u>	<u>8K</u>	
E-A-R Plugs/Blue Point GA-3000										
Mean Attenuation	31	30	37	39	34	44	46	46	45	20
Standard Deviation	8.4	8.2	8.4	9.4	5.4	6.4	9.3	6.4	5.9	
E-A-R Plugs/Howard Leight Thunder 29										
Mean Attenuation	33	38	47	44	36	47	50	46	45	27
Standard Deviation	5.6	9.0	8.6	5.8	5.2	6.2	6.0	5.2	4.2	
E-A-R Plugs/Peltor Twin Cup Muffs										
Mean Attenuation	31	32	43	42	38	50	50	50	48	26
Standard Deviation	6.7	7.6	8.2	6.3	5.2	6.3	5.8	3.4	3.3	
E-A-R Plugs/Safety Direct RBW-71										
Mean Attenuation	31	37	44	41	38	48	49	48	46	28
Standard Deviation	6.5	6.3	8.2	5.3	5.4	6.0	4.1	3.2	4.4	

Plug and Communication	Octave Band Attenuation									NRR
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Headset										
E-A-R Plugs / Astrocom H-157-A	<u>125</u>	<u>250</u>	<u>500</u>	<u>1K</u>	<u>2K</u>	<u>3.1K</u>	<u>4K</u>	<u>6.3K</u>	<u>8K</u>	
Mean Attenuation	29	38	47	49	47	52	52	51	49	32
Standard Deviation	5.0	5.0	6.5	4.1	8.1	6.3	4.2	4.2	4.0	
V51R / Astrocom H-157-A										
Mean Attenuation	25	25	30	38	47	49	49	46	45	21
Standard Deviation	8.3	7.2	5.3	4.4	6.0	7.5	5.9	4.3	5.6	
E-A-R Plugs / Roanwell										
Mean Attenuation	32	34	35	37	34	46	48	48	45	20
Standard Deviation	5.6	7.6	8.4	8.0	6.3	7.2	7.1	7.2	5.6	
NSN 5965-01-121-2319										

Plug and Helmet	Octave Band Attenuation									NRR
E-A-R Plugs / Gentex 53P	<u>125</u>	<u>250</u>	<u>500</u>	<u>1K</u>	<u>2K</u>	<u>3.1K</u>	<u>4K</u>	<u>6.3K</u>	<u>8K</u>	
Mean Attenuation	31	30	41	41	45	51	54	55	53	29
Standard Deviation	5.6	5.5	6.0	4.7	4.3	5.7	4.9	5.9	5.8	
E-A-R Plugs / Gentex 55P										
Mean Attenuation	26	27	41	44	46	55	55	56	58	28
Standard Deviation	4.7	5.0	5.8	5.1	5.3	5.0	4.9	6.7	7.0	
V51R Plugs / Gentex 53P										
Mean Attenuation	22	23	34	36	46	54	56	57	56	24
Standard Deviation	4.4	4.8	5.4	3.5	5.4	5.6	4.6	5.4	5.5	

C-A Values

Device	-2 thru 0	1 thru 3	4 thru 7	8 thru 10	11 and up
E-A-R Classic (Foam Disp. earplug)	26	23	20	20	19
Howard Leight Max earplug	26	22	20	19	19
E-A-R 9000 earmuff	24	23	19	16	13
Willson 365A earmuff	30	26	23	20	18
Tasco 2900 earmuff	33	30	26	22	19
Howard Leight QM 24 earmuff	26	22	18	15	13
Bilsom Viking 29 earmuff	34	30	26	22	19
Bilsom 707 impact earmuff	25	21	18	15	13
Safety Direct RBW 71 earmuff (blue)	27	22	17	14	11
Peltor H7A earmuff	31	27	22	18	15
Tasco Golden Eagle #2950 earmuff	32	30	27	23	21
Cabot 1720 earmuff	28	23	18	14	11
E-A-R 1000 earmuff	25	22	18	15	12
Gentex Wolf Ear earmuff	24	21	18	15	12
Aearo 1000 earmuff	29	23	18	15	12
Blue Point GA 3000 earmuff	32	29	24	21	12

Bilsom 727 earmuff	31	27	22	18	14
North Earmuff 28-45-00	23	19	14	11	8
Wilson 365 Sound Barrier earmuff	31	27	23	20	17
E-A-R 820 earmuff	26	20	15	12	10
3M 1435 earmuff	29	24	19	16	13
3M 1440 earmuff	31	27	22	19	16
Peltor H10A earmuff	33	31	26	23	19
Tasco Sound Shield earmuff	34	31	27	23	21
MSA Mark IV earmuff	30	25	21	18	15
Howard Leight Thunder 29 earmuff	29	25	21	18	15
David Clark 310 earmuff	32	28	24	20	16
Bilsom Blue 2308 earmuff	26	20	15	12	10
Vallen Pro-Max I	33	30	26	22	19
David Clark H-133 headset	30	28	27	26	24
Peltor Lightcom headset	31	26	22	19	16
Roanwell Headset 495-622-001-604	25	23	21	18	16

II. Explanation of NRR

The Noise Reduction Rating (NRR) is an attempt to describe hearing protection via a single number description. This was proposed to simplify complex attenuation data for the general public and was made a legal requirement by the Environmental Protection Agency (EPA) for manufacturers of hearing protection. The NRR has been widely criticized by the scientific community as being an oversimplification and a compromise. Applying complete octave band data provides far more accuracy. Furthermore, the NRR was intended to be subtracted from C-weighted noise data. However, OSHA inspection teams found the NRR was often being used in conjunction with A-weighted noise data in private industry. OSHA mandated a seven (7) dB correction factor to account for the difference in low-frequency weighting between A and C filters on sound measurement equipment when the NRR is subtracted from A-levels. *Bottom line: You do not need to subtract an additional 7 dB from the NRR if your sound levels are obtained in C-weighted sound pressure levels.*

SAMPLE NRR: Source—NIOSH Hearing Protector Compendium

Octave band center frequency, Hz	125	250	500	1000	2000	3000	4000	6000	8000	Log Sum
1. Assumed pink noise (dB) – “flat”	100	100	100	100	100		100		100	
2. C-weighting corrections (dB)	-0.2	0	0	0	-0.2		-0.8		-3	
3. Unprotected ear C-weighted level	99.8	100	100	100	99.8		99.2		97	107.9
4. A-weighting corrections (dB)	-16.1	-8.6	-3.2	0	1.2		1.0		-1.1	
5. Unprotected ear A-weighted level	83.9	91.4	96.8	100	101.2		101		98.9	
6. Average attenuation at each frequency (example)	21	22	23	29	41	43	47	41	36	
	21	22	23	29	41		45*		38.5*	
7. Std. deviation in dB at each frequency (example)	3.7	3.3	3.8	4.7	3.3	3.3	3.4	6.1	6.5	

(Std. deviation x 2)	x2	x2	x2	x2	x2				
	7.4	6.6	7.6	9.4	6.6		6.7**		12.6**
8. Attenuation less SD in dB at each frequency (line 6 - line 8)	13.6	15.4	15.4	19.6	34.4		38.3		25.9
9. Protected ear A-weighted level (average attenuation minus two std. deviations develops the A-weighted levels (line 5 - line 8))	70.3	76.0	81.4	80.4	66.8		62.7		73.0 85.1
10. NRR is unprotected ear "C" level (line 3) minus protected ear "A" level (line 9) minus 3 dB									19.8 NRR=20

* Average attenuation at 3000 and 4000 Hz and at 6000 and 8000 Hz.

** Summed standard deviation for 3000 and 4000 Hz and 6000 and 8000 Hz.

SAMPLE NRR: Source—NIOSH Hearing Protector Compendium

NOTE:

When C-weighted sound level measurement is available, the following formula should be used:

Noise Level in dB(C) - Protector NRR = presumed at-the-ear exposure

When A-weighted sound level measurement is available, the following formula should be used:

Noise Level in dB(A) - (Protector NRR - 7 dB) = presumed at-the-ear exposure

III. Explanation of Method A vs. Method B

ANSI Test Method A: American National Standards Institute (ANSI) S12.6-1984 for devices tested using method A. Evaluation of HPDs with trained and experienced test subjects. Fitting the HPD is assisted/facilitated by the experimenter. This is considered best-case data.

ANSI Test Method B: ANSI S12.6-1997 for devices tested using method B. Evaluation of HPDs with naïve test subjects; must obtain their instructions for fitting and use solely from the manufacturer's written instructions accompanying the packaging. No instruction from the experimenter is allowed. This method was proposed to estimate field performance in commercial industry. However, there is debate about how well it suits DoD service members in a hearing conservation program receiving annual training (which is why the May 1999 List of Approved HPDs was rescinded). Devices tested using method B in this report are highlighted and italicized. These method B values are often significantly less than method A values for insert and plug types of HPDs. You will simply be conservative using them. There appears to be relatively little difference between methods A and B for muffs and headsets.

The DoD Tri-Service Hearing Conservation Working Group is the organization determining how attenuation testing is to be conducted for DoD (which standard and which method, etc.). The manufacturers of hearing protection use older versions of the ANSI S.12 standard as bound by the Environmental Protection Agency (EPA). The EPA doesn't require the updated versions because that office within the EPA was zero funded.

IV. Explanation of C – A

The C – A method was devised by USAF researchers. It is a statistical model based on linear regressions involving 50 representative USAF noises encompassing all the acoustical spectra to which USAF personnel are exposed. Please see AFOSH 48-20 for instruction on application of C - A data. The list will be expanded to include all HPDs in the near future (project awaits funding).

V. Order of Preference for calculating HDP noise attenuation

Octave band is the preferred method to calculate HPD noise attenuation (see instructions in AFOSH STD 48-19) , where octave band measurements have not been collected, noise attenuation may be estimated from A-weighted and C-weighted sound pressure levels of the noise source. NRR is the *LEAST* preferred method of estimating HPD noise attenuation.

VI. Points of Contact

For further information please contact the Aural Displays & Bioacoustics Branch of the Human Effectiveness Directorate at the Air Force Research Laboratory, Wright-Patterson AFB.

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